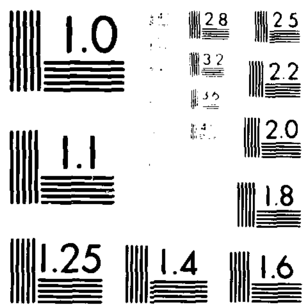
AD-A097 647 ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH (ENGLAND) F/G 11/5
ABRASION AND HYDROSTATIC HEAD OF WEATHERED RUBBER-COATED FABRIC--ETC(U)
OCT 80 J E SWALLOW, A R WAKEFIELD
UNCLASSIFIED RAE-TR-80124 MOAD-306 NL

1 OF 1
AD A097647

END
DATE
FILMED
5 81
DTIC



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

BR77046✓

UNLIMITED

TR 80124✓

TR 80124

LEVEL II

ROYAL AIRCRAFT ESTABLISHMENT

*

Technical Report 80124

and

MATERIALS QUALITY ASSURANCE DIRECTORATE

Report 306

October 1980

ABRASION AND HYDROSTATIC HEAD OF WEATHERED RUBBER-COATED FABRICS

RAE-TR-80124

by

J.E. Swallow

A.R. Wakefield

MQAD, DRIC

306, BR-77046

DTIC ELECTE APR 13 1981 S D E

*

AD A097 647

Procurement Executive, Ministry of Defence

Farnborough, Hants

DTIC FILE COPY

UNLIMITED

310450 81 4 9 044

UDC 677.55 : 620.193.1/.2 : 539.378.6 : 532.111

ROYAL AIRCRAFT ESTABLISHMENT

Technical Report 80124

and

MATERIALS QUALITY ASSURANCE DIRECTORATE

Report 306

Received for printing 17 October 1980

ABRASION AND HYDROSTATIC HEAD OF WEATHERED RUBBER-COATED FABRICS

by

J. E. Swallow

A. R. Wakefield*

SUMMARY

The abrasion mass loss and hydrostatic head of a nylon and of a cotton fabric, each coated with natural rubber, neoprene, polyurethane (PU) or chlorosulphonated polyethylene (CSPE) and exposed to various weathering conditions, were determined.

Correlations between hydrostatic head and abrasion mass loss were generally low.

During abrasion, coated nylon fabrics lost more mass than coated cotton fabrics. CSPE was most susceptible to abrasion, particularly on nylon, though with little dependence on conditions of exposure. Neoprene was worse on cotton. PU had the lowest mass loss and least susceptibility to exposure conditions, except at Innisfail. Natural rubber lost more mass on abrasion than neoprene or PU, especially at PERME. Load during exposure had a negligible effect.

Departmental Reference: Mat 411

* QAD Mats, Chorley, Lancs

LIST OF CONTENTS

1 INTRODUCTION

The exposure of rubber-coated fabrics for up to 1 year of weathering, and the effects of this on their flexibilities, strengths and breaking extensions, and tearing strengths have previously been reported[1-3].

In a collaborative trial involving several Establishments of MOD(PE) and JTRU, nylon and cotton base fabrics of similar mass per unit area were coated with natural, neoprene, polyurethane (PU) or chlorosulphonated polyethylene (CSPE) rubber. These coated fabrics were exposed for 3, 6 or 12 months, and a second period of 6 months ('6 months stepped' or '6S') commencing at the end of the first, under loads of 1% or 10% of the nominal breaking strengths. Pieces of fabric were positioned at 45^{o} to the horizontal and facing the equator at a site in the UK (PERME, Waltham Abbey) and at two sites in Queensland (hot, dry at Cloncurry, and hot, wet, cleared jungle at Innisfail).

The coated nylon fabrics were found to be thicker, heavier and less flexible than the coated cotton fabrics; PU rubber, particularly on nylon, stiffened more than the other rubbers during exposure. The coated nylon fabrics were stronger and more extensible than the cotton ones, but those coated with natural-rubber lost strength and extensibility at a faster rate when exposed under load. Nylon coated with PU was initially stronger and more extensible than when coated with the other rubbers, but lost these properties faster at Innisfail. Extension was more severely affected than strength by load during exposure. The coated nylon fabrics had higher tear strengths than the cotton ones, but were more variable. PU-coated nylon increased in tear strength in Australia due to coating failure, but natural-rubber coated cotton decreased on exposure in UK. Load during exposure increased the loss of tear strength of the natural-rubber coated fabrics.

To complete the experimental work envisaged when the trial was set up, mass losses on abrasion and the subsequent hydrostatic heads of the fabrics were determined. The present Report gives the results and their analyses.

2 DETERMINATION OF ABRASION AND HYDROSTATIC HEAD

(a) Abrasion

The abrasion of each specimen was measured[4] using a Martindale abrasion tester situated in an atmosphere of 65% relative humidity at 20^{o}C. The abradant was 180C silicon carbide paper acting under a pressure of 8.19 kN/m^2 over a working abradant head area of 6.45 cm^2. The specimen and abradant were, however, reversed in position compared with the standard because wear was more uniform and the abraded area was larger, allowing sufficient area for subsequent hydrostatic head tests. Abrasion was continued until a degree of wear judged by visual appearance had been attained, the number of cycles being noted. Specimens were weighed before and after abrasion. The test was repeated on the other face of the fabric. Two replicates were available for most of the exposure conditions.

124

(b) Hydrostatic head

After abrasion the specimens were subjected under standard[5] conditions to steadily increasing water pressure on one face until penetration occurred. The pressures at which the first, third and multiple bubbles were observed were measured by water manometer or, for pressures between about 100cm and 300cm head of water, by mercury manometer.

3 ARRANGEMENT OF RESULTS

The sums of the losses of mass from both faces over the area abraded during the (variable) numbers of cycles of abrasion actually applied are given in Table 1 (tests a), together with the hydrostatic head in cm water pressure after these cycles (tests b). The first bubble was used as the criterion for the hydrostatic head since more results were available within the capacity of the instrument. Tests a and b were subjected to correlation analysis by fabric and by site, analysis of variance of the hydrostatic head results not being possible because of the different numbers of cycles applied to the specimens.

These correlations are described in section 4 before dealing with the effects of exposure on abrasion. This was because the actual results in Table 1 were used for the correlations, whereas derived values were used for the abrasion effects.

To analyse the abrasion, the mass losses were normalised to g/m^2 per 1000 cycles assuming that the losses were linear with number of cycles over the range considered. The results for each face were then summed and are given in Table 2. It was thought necessary to adopt this procedure rather than to analyse each face separately because, although the trial schedule stipulated that the face carrying identifying markings should be exposed down-facing, there was doubt as to whether this was so in all cases. The reason for this doubt was that, assuming that the exposed face would be more susceptible to abrasion, the difference between the mass loss from the unmarked and marked faces should be positive. However, 39% of all 395 differences, 27% of the 99 differences greater than 10 g/m^2 per 1000 cycles, and 16% of the 49 differences greater than 20 g/m^2 per 1000 cycles were negative.

The abrasion results were divided into the same nine sets as for breaking strength[2] and tear strength[3], it not being possible to consider the results as a whole because of specimen losses. The 342 usable abrasion values were analysed by computer, using as the sets the following columns from Table 2:

Set	No. of columns in set	No. of results in set	Columns from Table 2 used	Brief description
(a)	2	32	A,B	Controls
(b)	6	96	C,D,K,L,S,T	3 months
(c)	12	192	C,E,G,I,K,M,O,Q,S,U,W,Y	1%
(d)	24	96	C-Z	Natural-rubber
(e)	8	128	C-J	PERME
(f)	6	96	A,B,C,E,G,I	PERME, 1%, with controls
(g)	6	96	A,B,K,M,O,Q	Cloncurry, 1%, with controls
(h)	6	96	A,B,S,U,W,Y	Innisfail, 1%, with controls
(i)	24	144	C-Z	Nylon with three rubbers

4 CORRELATION OF ABRASION AND HYDROSTATIC HEAD

The linear and quadratic correlations between the abrasion mass losses and the corresponding hydrostatic heads, by fabric and by site, are given in Table 3, together with the variance ratios for the significance of these correlations. It was not possible to subdivide the data further, *eg* by time, because of too few degrees of freedom. By comparing means, however, it appears that for a given amount of abrasion, the hydrostatic head of PU on nylon was low, whilst for CSPE it was high.

It might be expected that a greater loss of coating would be associated with a lower hydrostatic head, *ie* the linear correlations should be negative. Inspection of Table 3 shows that this was so for 24 of the linear 32 correlations calculated. However, the significance of only 12 of the 32 was above the 95% probability level, and, of these 12, three, all at PERME and including the only correlation significant at the 99.9% level of probability, were positive. Addition of the quadratic components into the correlations did not alter any of the conclusions relating to the linear correlations, although the significance of a few of the quadratic components indicated that curvature might play a part in some instances. Since high hydrostatic head would also be expected to occur with low abrasions on unexposed fabrics, a U-shaped curve is implied in some instances. High hydrostatic heads tended to be associated with high abrasion after exposures of 3 months, suggesting that time might be an influencing factor, but there was no means of confirming this from the recorded data. However, it could mean that in some circumstances the coating may have degraded to an extent such that on abrasion the amount or type of detritus produced improved coating integrity.

5 TEST FOR EQUALITY OF ABRASION ERROR VARIANCES

The values of χ^2 based on cell ranges (in Table 2) in each set are given in Table 4. Also given are the numbers of omissions of the highest of the ranges needed to reduce χ^2 so that the probability was above the 5% level. The omissions needed were as follows:

Set	Omissions needed
(a), (d), (g), (h), (i)	None
(b)	Nylon/CSPE Column C; Cotton/natural Column C
(c)	Nylon/CSPE Column E; Nylon/PU Column U
(e)	Nylon/CSPE Columns F, J, E, C; Cotton/natural Column J; Cotton/neoprene Column H
(f)	Nylon/CSPE Columns E, C; Cotton/natural Column C

There was a preponderance here of nylon/CSPE at PERME. Analysis of variance was performed on all the sets, but circumspection needed to be exercised in respect of conclusions relating to the fabrics and conditions having high error particularly in the higher order interactions.

6 ANALYSIS OF VARIANCE AND MEANS OF ABRASION MASS LOSS

6.1 General

The analysis of errors is given in Table 5. The error variance was lowest in the controls and highest at Cloncurry. Except at Cloncurry, coefficients of variation were around 10%. The lowest overall abrasion loss was in the controls, and the highest in nylon and in natural rubber.

Variance ratios derived from analysis of variance within each set are given in Table 6. The effects are discussed in order of occurrence in Table 6 rather than in order of importance since the latter could differ in the various sets. Only those effects which had better than 99.9% probability of being correct were considered.

The mean mass losses on abrasion, where they were significantly dependent on factors, are given in Table 7, and the associated differences required between means in Table 8.

6.2 Effect of fabric (F)

The variance ratios for F in Table 6 were upwards of 100 in all the sets, indicating that the base fabric was important in affecting abrasion mass loss. The losses from nylon were greater than those from cotton, generally by about 40% (Table 7).

6.3 Effect of rubber (R)

In all the sets the variance ratios for rubber were upwards of 200 and the highest of all the factors, indicating that the rubber was the most important factor determining abrasion. The order was generally CSPE > natural > neoprene > PU, though in the controls the differences between natural and neoprene, or between neoprene and PU were not significant, nor were those between natural and neoprene in sets (g) or (h). An experimental observation on the PU-coated fabrics, however, was that the coating softened during abrasion and tended to spread out under load, rather than be removed; this was most noticeable after exposure.

6.4 Effect of time (T)

Time was significant in all the sets except (a). The latter indicated that the final control determinations did not differ from the originals. In the other sets, the exposed specimens had greater abrasion losses than the unexposed, and generally the 12 months losses were highest, though not always significantly so. The high loss in set (h) at 6 months is anomalous (see also the TS, FT and FRT interactions).

6.5 Effect of load (L)

Load during exposure played a negligible part in determining abrasion losses. The effect is not listed in Table 7.

6.6 Effect of site (S)

Site was significant in all sets. The abrasion losses at PERME were greater than at the other sites, though in set (b) not significantly more than at Cloncurry. Cloncurry was worse than Innisfail in sets (b) and (i), but there was no demonstrated difference between them in sets (c) or (d).

6.7 Fabric × rubber interaction (FR)

The variance ratios for the FR interaction were upwards of 100 in all sets, indicating the importance of the effect of the base fabric on the rubber type. In particular, CSPE on nylon, whether exposed or unexposed, lost more on abrasion than when on cotton, whereas neoprene on cotton tended to lose more than neoprene on nylon.

6.8 Fabric × time interaction (FT)

Only in set (h) was this interaction significant, and even there it was at a lower level of probability than most other effects. Since set (h) contained the anomalous 6-month results noted in the discussion on the T effect, it is doubtful whether a time effect which is different for the two base fabrics has been demonstrated. The interaction is therefore not listed in Table 7.

6.9 Fabric × load interaction (FL)

The effect of fabric was not dependent on the load during exposure, and is not listed in Table 7.

6.10 Fabric × site interaction (FS)

The poorer abrasion performance of nylon was less marked after exposure at Innisfail than at the other sites.

6.11 Rubber × time interaction (RT)

Time affected the abrasion losses of the various rubbers to differing extents, though it is not clear to what this should be ascribed. CSPE occasionally appeared to be anomalously high, though not at any consistent time. The doubtful columns in section 5 did not seem to play a part in modifying the results.

6.12 Rubber × load interaction (RL)

The abrasion of the various rubbers was not affected by the load during exposure. The interaction is therefore not listed in Table 7.

6.13 Rubber × site interaction (RS)

The abrasion of the rubbers was affected by the site. The natural-rubber at PERME and PU at Innisfail in set (c) had the poorest results (see FRS and FRTS interactions).

6.14 Time × load interaction (TL)

Time of exposure did not increase the effect of load on abrasion.

6.15 Time × site interaction (TS)

The sites differed at different times of exposure. In sets (d) and (i), 12 months at PERME gave high abrasion, as did 6 months at Innisfail, though the latter result is anomalous.

6.16 Load × site interaction (LS)

The effect of site was not dependent on load during exposure. The interaction is therefore not listed in Table 7.

6.17 FRT interaction

This interaction was significant in sets (c), (e), (f) and (h), but not in (a) or (g). Natural-rubber on nylon at 12 months and, more particularly, PU on nylon at 6 and 12 months in sets (c) and (h) gave abnormally high abrasion losses (see FRTS interaction).

6.18 FRL interaction

The FR interaction was not dependent on load during exposure, and is therefore not listed in Table 7.

6.19 FRS interaction

Natural-rubber on nylon did rather badly at PERME. In addition, CSPE on nylon was similarly poorer at Cloncurry in set (b), and PU on nylon at Innisfail in set (c).

6.20 FTL interaction

The FT interaction was not dependent on load during exposure, and is therefore not listed in Table 7.

6.21 FTS interaction

In set (c), the significance of this interaction seems to have been due to the somewhat poorer abrasion performance of nylon and cotton fabrics at Innisfail after 6 months, whilst in set (d) it was due to the nylon and cotton at PERME after 12 months.

6.22 FLS and RTL interactions

The FS and RT interactions were not dependent on load during exposure, and are therefore not listed in Table 7.

6.23 RTS interaction

The significance of this interaction seems to have been due to the greater abrasion loss in natural-rubber after being at PERME for 12 months.

6.24 TLS, LSR and FRTL interactions

The TS, RS and FRT interactions were not dependent on load during exposure, and are not listed in Table 7.

6.25 FRTS interaction

The significance of this interaction appears to have been largely due to the poorer performance in abrasion of PU on nylon at Innisfail after 6 months, though the result is anomalous in that it is higher than either the 6S results or the average of the 3 and 12 month results.

6.26 FTLS, FLSR and RTLS interactions

The FTS, FRS and RTS interactions were not dependent on load, and are not listed in Table 7.

7 CONCLUSIONS

(1) The hydrostatic head and mass loss on abrasion of nylon and cotton fabrics of similar mass per unit area, and coated with natural, neoprene, PU or CSPE rubbers, have been determined after exposure to weathering in UK or Australia for up to 1 year under a load of 1% or 10% of the nominal breaking load.

(2) The expected decrease in hydrostatic head with abrasion was not generally confirmed; correlations between them were low.

(3) For a given amount of abrasion on nylon, the hydrostatic head of PU coating was low, whilst for neoprene it was high.

(4) Abrasion losses from nylon were about 40% higher than from cotton.

(5) CSPE suffered more abrasion losses than the other rubbers, especially on nylon, but were less affected by weathering.

(6) Natural-rubber lost more in abrasion than did neoprene or PU, especially at PERME.

(7) PU had the lowest abrasion loss and least susceptibility to weathering, except at Innisfail, though the coating softened and tended to spread out rather than be removed.

(8) Neoprene lost more in abrasion when on cotton than when on nylon.

(9) The effect of load during exposure, whether as a main factor or in an interaction, had a negligible effect on abrasion.

Table 1

ABRASION AND CORRESPONDING HYDROSTATIC HEAD OF WEATHERED COATED FABRICS

Site		Controls				PERME											
Time, months		Original		Final		3				6				12			
Load level, %						1		10		1		10		1		10	
Test		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Fabric	Rubber																
Nylon	Natural	0.21 0.17	245 189	0.237 0.213	188 169	0.28 0.28	95 122	0.28 0.31	95 95	0.210 0.239	32 35	0.186 0.200	22 15	0.167 0.163	42 36	0.167 0.138	22 28
Nylon	Neoprene	0.28 0.26	272 272	0.273 0.275	>268 >268	0.30 0.29	>272 >272	0.39 0.40	258 272	0.364 0.320	>322 268	0.370 0.319	308 241	0.332 0.283	>268 >268	0.300 0.263	60 161
Nylon	PU	0.23 0.25	281 91	0.177 0.187	24 24	0.20 0.20	41 41	0.19 0.19	27 68	0.181 0.184	30 17	0.132 0.158	12 14	0.135 0.136	9 20	0.092 0.111	12 13
Nylon	CSPE	0.78 0.74	119 95	0.590 0.591	32 100	0.77 0.65	177 163	0.65 0.56	150 150	0.362 0.455	241 233	0.417 0.553	265 222	0.519 0.532	121 102	0.496 0.516	134 84
Cotton	Natural	0.13 0.10	190 82	0.201 0.180	76 214	0.33 0.34	41 119	0.28 *	163 *	0.241 0.258	27 38	0.287 *	24 *	0.283 0.261	19 25	0.224 0.236	14 10
Cotton	Neoprene	0.19 0.19	82 82	0.333 0.312	59 74	0.25 0.26	272 245	0.27 0.29	177 272	0.258 0.312	221 >322	0.221 0.309	228 245	0.374 0.352	100 114	0.309 0.330	53 127
Cotton	PU	0.29 0.22	177 245	0.246 0.232	134 134	0.33 0.24	204 272	0.29 0.29	41 150	0.128 0.128	>308 *	0.138 0.145	70 *	0.228 0.225	50 18	0.195 0.202	* 20
Cotton	CSPE	0.23 0.26	231 231	0.540 0.515	197 28	0.49 0.41	218 272	0.52 0.45	272 272	0.404 0.388	230 161	0.435 0.396	>322 77	0.598 0.537	51 82	0.511 0.539	88 25

Table 1 (continued)

Site		PERME				Cloncurry											
Time, months		6S				3				6				12			
Load level, %		1		10		1		10		1		10		1		10	
Test		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Fabric	Rubber																
Nylon	Natural	0.194	45	0.200	16	0.191	40	0.207	70	0.259	150	0.277	10	0.328	36	0.337	47
		0.193	30	0.192	28	0.200	80	0.195	70	0.265	147	0.250	72	0.292	58	0.305	30
Nylon	Neoprene	0.350	>268	0.297	>268	0.350	261	0.329	255	0.421	>268	0.405	>268	0.488	241	0.423	89
		0.335	>268	0.310	>268	0.312	>268	0.337	>268	0.434	>268	0.408	>268	0.453	>268	0.480	78
Nylon	PU	0.132	28	0.154	16	0.111	15	0.080	208	0.101	45	-	-	0.143	27	-	-
		0.150	18	0.159	14	0.097	17	0.102	201	0.102	50	-	-	0.195	17	-	-
Nylon	CSFE	0.577	118	0.511	70	0.461	60	0.476	214	0.549	63	0.590	14	0.555	28	0.626	32
		0.583	83	0.473	78	0.461	75	0.497	107	0.525	16	0.545	35	0.523	71	0.603	28
Cotton	Natural	0.317	161	0.258	56	0.261	26	0.227	214	0.331	38	0.325	7	0.379	69	0.390	54
		0.300	107	0.267	72	0.236	163	0.218	60	0.330	>268	0.300	53	0.365	67	0.390	48
Cotton	Neoprene	0.342	85	0.293	93	0.268	94	0.295	65	0.328	65	-	-	0.365	93	-	-
		0.335	174	0.251	161	0.267	40	0.331	25	0.302	174	-	-	0.336	86	-	-
Cotton	PU	0.255	8	0.191	62	0.182	45	0.183	>268	0.245	>268	0.219	>268	0.171	41	-	-
		0.208	30	0.208	54	0.175	241	0.186	*	0.228	>268	0.220	29	0.167	32	-	-
Cotton	CSPE	0.514	134	0.486	60	0.463	45	0.432	194	0.503	181	-	-	0.591	134	-	-
		0.503	161	0.502	134	0.426	82	0.418	95	0.531	212	-	-	0.630	175	-	-

Table 1 (continued)

Site		Cloncurry				Innisfail							
Time, months		6S				3				6			
Load level, %		1		10		1		10		1		10	
Test		a	b	a	b	a	b	a	b	a	b	a	b
Fabric	Rubber												
Nylon	Natural	0.290	92	0.301	16	0.195	84	0.213	268	0.278	47	0.236	19
		0.268	65	0.268	33	0.185	77	0.181	201	0.259	65	0.244	28
Nylon	Neoprene	0.484	268	0.372	221	0.252	287	0.268	>268	0.334	>268	0.321	>268
		0.434	>268	0.399	134	0.235	236	0.304	>268	0.361	>268	0.339	>268
Nylon	PU	0.055	60	-	-	0.089	30	0.078	5	0.402	7	0.303	6
		0.066	20	-	-	0.072	*	0.086	*	0.343	7	0.351	3
Nylon	CSPE	0.610	126	0.550	26	0.379	244	0.425	94	0.417	21	0.347	72
		0.560	80	0.546	80	0.413	161	0.399	127	0.394	87	0.343	80
Cotton	Natural	0.358	20	0.303	58	0.275	121	0.208	80	0.316	21	0.298	75
		0.342	52	0.274	71	0.241	154	0.199	80	0.312	70	0.314	52
Cotton	Neoprene	0.326	86	0.292	121	0.290	85	0.270	181	0.283	90	0.228	48
		0.289	*	0.289	134	0.283	75	0.252	90	0.279	81	0.234	39
Cotton	PU	0.212	>268	0.250	150	0.119	85	0.130	45	0.392	10	-	-
		0.209	>268	0.253	241	0.089	75	0.099	12	0.381	6	-	-
Cotton	CSPE	0.589	52	0.561	116	0.450	>268	0.463	55	0.491	127	0.512	83
		0.626	126	0.542	50	0.457	201	0.430	87	0.548	143	0.490	163

Table 1 (concluded)

Site		Innisfail							
Time, months		12				6S			
Load level, %		1		10		1		10	
Test		a	b	a	b	a	b	a	b
Fabric	Rubber								
Nylon	Natural	0.344 0.327	18 40	0.435 0.390	18 19	0.333 0.333	55 72	0.337 0.318	13 15
Nylon	Neoprene	0.432 0.425	67 93	0.385 0.376	43 47	0.491 0.441	273 276	0.437 0.403	126 80
Nylon	PU	0.303 0.306	9 8	- -	- -	0.081 0.078	45 43	- -	- -
Nylon	CSPE	0.774 0.768	42 11	0.647 0.621	19 30	0.805 0.724	9 20	0.625 0.606	20 20
Cotton	Natural	0.351 0.335	88 137	0.343 0.324	68 90	0.351 0.315	88 87	0.270 0.302	89 42
Cotton	Neoprene	0.367 0.350	62 57	- -	- -	0.332 0.301	85 54	0.345 0.294	47 80
Cotton	PU	0.516 0.359	12 10	* 0.259	* 10	0.264 0.206	23 23	0.211 0.205	22 34
Cotton	CSPE	0.569 0.544	41 163	0.541 0.489	55 161	0.626 0.581	134 >268	0.496 0.401	59 56

NOTES

Test a — Abrasion, total mass loss from both sides, g, for number of cycles used in test

Test b — Hydrostatic head, cm head of water to produce first bubble, on abraded specimen

Duplicate results refer to replication

\- Specimen lost or damaged during exposure

* No test made

\> Beyond range of apparatus to measure

Table 2

ABRASION OF WEATHERED COATED FABRICS, g/m^2 PER 1000 CYCLES

Site		Controls		PERME								Cloncurry			
Time, months		Original	Final	3		6		12		6S		3		6	
Load level, %				1	10	1	10	1	10	1	10	1	10	1	10
Column		A	B	C	D	E	F	G	H	I	J	K	L	M	N
Fabric	Rubber														
Nylon	Natural	35.80 29.08	34.70 25.41	74.97 74.97	74.97 83.00	83.50 86.73	73.58 78.64	129.40 125.17	111.78 107.31	80.75 90.87	93.82 77.40	43.91 46.07	49.39 46.61	62.07 55.71	82.41 74.37
Nylon	Neoprene	14.72 17.41	14.86 13.96	53.54 51.76	45.13 41.81	33.13 37.32	39.12 36.40	54.65 42.61	50.53 46.75	42.38 39.24	38.34 35.77	48.40 42.26	43.87 46.81	51.84 44.23	46.95 42.49
Nylon	PU	20.53 18.44	19.42 16.74	21.04 21.04	19.70 20.46	17.90 18.00	19.61 22.55	13.10 12.43	7.84 10.49	14.73 15.73	27.71 26.94	13.96 11.35	9.94 11.14	10.51 9.94	- -
Nylon	CSPE	104.42 99.07	109.46 109.79	121.04 99.95	98.62 86.12	98.71 123.89	117.17 149.63	107.25 108.83	103.17 104.33	133.79 130.13	149.48 123.73	138.56 138.29	142.17 148.93	101.36 96.94	108.97 101.06
Cotton	Natural	15.80 11.78	16.95 15.19	66.94 50.87	59.79 -	47.22 53.52	59.60 -	95.89 82.40	103.57 85.53	48.15 44.80	65.38 44.30	45.62 36.17	37.38 33.25	43.89 39.37	51.72 40.53
Cotton	Neoprene	21.68 18.74	27.88 25.73	44.62 40.16	41.50 51.76	71.14 73.33	59.06 60.97	87.68 79.68	93.55 77.21	69.54 56.96	61.26 48.98	53.90 56.73	52.65 61.12	67.76 62.57	- -
Cotton	PU	15.93 15.68	11.53 10.87	25.24 18.35	22.18 22.18	14.77 8.95	15.24 13.50	14.15 17.38	16.07 15.25	14.70 12.28	11.34 14.11	16.60 16.70	16.64 16.94	19.80 18.31	18.65 22.47
Cotton	CSPE	31.14 34.01	51.41 44.81	49.96 41.39	52.70 45.78	28.67 26.92	31.92 27.97	46.12 42.94	42.20 37.07	57.18 51.77	40.04 38.98	47.17 38.76	40.81 36.12	53.80 54.20	- -

Table [illegible] (concluded)

Site		Cloncurry				Innisfail							
Time, months		12		68		3		6		12		[illegible]	
Load level, %		1	10	1	10	1	10	1	10	1	10	1	10
Column		O	P	Q	R	S	T	U	V	W	X	Y	Z
Fabric	Rubber												
Nylon	Natural	63.45 56.50	71.89 65.11	51.09 48.66	[illegible] 46.80	53.29 47.03	41.17 43.09	67.45 54.86	60.58 62.38	63.70 57.40	63.03 53.10	40.06 39.72	33.11 31.03
Nylon	Neoprene	50.33 47.09	54.60 63.58	[illegible] 39.77	37.41 39.41	39.95 35.92	28.80 33.59	38.07 39.50	37.19 40.03	47.60 46.56	57.43 57.97	36.94 29.59	[illegible] 32.76
Nylon	EP	73.10 79.04	- -	[illegible] 10.42	- -	8.90 7.43	7.25 8.23	145.87 125.03	119.31 130.84	53.80 54.32	- -	13.37 10.55	- -
Nylon	CSPE	110.15 105.01	108.04 99.48	113.28 103.16	[illegible] 96.60	88.88 91.24	95.85 88.35	120.96 116.87	115.81 113.98	86.45 85.75	77.97 74.68	89.73 80.76	[illegible] [illegible]
Cotton	Natural	49.66 48.41	58.91 57.15	38.36 36.52	48.04 42.58	55.45 41.76	33.31 35.07	61.70 60.55	71.45 64.92	52.68 48.47	51.30 49.58	40.35 35.39	[illegible] 35.62
Cotton	Neoprene	67.98 66.70	- -	48.30 50.57	53.11 54.58	48.12 46.39	52.33 48.80	59.92 57.81	69.54 69.79	80.32 76.54	- -	55.50 50.13	52.67 43.87
Cotton	EP	11.61 12.00	- -	14.00 13.73	18.20 20.25	12.81 9.88	14.50 10.44	64.20 60.25	- -	33.06 22.03	- 24.19	18.08 16.32	19.82 19.33
Cotton	CSPE	39.83 41.84	- -	46.38 44.37	43.66 47.69	40.16 34.56	45.03 40.48	69.22 51.72	56.44 48.75	42.94 42.26	40.93 37.76	46.24 39.99	42.16 31.35

Table 3

CORRELATION OF ABRASION AND HYDROSTATIC HEAD

Fabric	Rubber	Site	No. of results	Linear correlation			Multiple correlation				Mean abrasion mass loss, g	Mean hydrostatic head, cm water
				Coefficient	Variance ratio a	Error degrees of freedom	Coefficient b	Variance ratio		Error degrees of freedom		
								Linear a	Quadratic a			
Nylon	Natural	All	52	-0.22	2.6	50	0.29	2.7	1.9	49	0.251	69
		PERME	16	+0.84	32.5	14	0.89	44.0	6.0	13	0.212	47
		Cloncurry	16	-0.25	1.0	14	0.41	1.0	1.6	13	0.265	64
		Innisfail	16	-0.59	7.3	14	0.64	7.7	1.3	13	0.288	63
Nylon	Neoprene	All	27	-0.22	1.4	25	0.33	1.4	1.6	24	0.374	192
		PERME	7	+0.67	4.0	5	0.68	3.3	0.1	4	0.337	224
		Cloncurry	8	-0.27	0.5	6	0.67	0.7	3.5	5	0.416	193
		Innisfail	10	-0.25	0.5	8	0.84	1.4	15.2	7	0.388	153
Nylon	PU	All	40	-0.14	0.8	38	0.15	0.7	0.1	37	0.168	41
		PERME	16	+0.65	10.2	14	0.72	11.6	2.6	13	0.156	24
		Cloncurry	10	-0.31	0.8	8	0.30	0.6	0.1	7	0.105	63
		Innisfail	10	-0.74	9.6	8	0.75	9.0	0.3	7	0.233	16
Nylon	CSPE	All	52	-0.36	7.3	50	0.40	7.6	1.5	49	0.552	94
		PERME	16	-0.23	0.8	14	0.61	1.2	6.6	13	0.540	149
		Cloncurry	16	-0.39	2.6	14	0.44	2.5	0.7	13	0.542	66
		Innisfail	16	-0.66	10.9	14	0.67	10.4	0.4	13	0.543	67
Cotton	Natural	All	49	-0.30	4.8	47	0.32	4.7	0.6	46	0.285	77
		PERME	14	+0.58	6.2	12	0.60	5.7	0.3	11	0.277	63
		Cloncurry	15	-0.52	4.8	13	0.66	[illegible]	3.5	12	0.313	67
		Innisfail	16	-0.19	0.5	14	0.19	[illegible]	[illegible]	13	0.297	[illegible]

Table 3 (concluded)

Fabric	Rubber	Site	No. of results	Linear correlation: Coeffi-cient	Linear correlation: Variance ratio a	Linear correlation: Error degrees of freedom	Multiple correlation: Coeffi-cient b	Multiple correlation: Variance ratio: Linear a	Multiple correlation: Variance ratio: Quadratic a	Multiple correlation: Error degrees of freedom	Mean abrasion mass loss, g	Mean hydrostatic head, cm water
Cotton	Neoprene	All	44	-0.24	2.6	42	0.31	2.6	1.8	41	0.295	112
		PERME	15	-0.62	8.1	13	0.62	7.5	0.0	12	0.296	171
		Cloncurry	11	-0.12	0.2	9	0.23	0.1	0.3	8	0.309	89
		Innisfail	14	-0.14	0.3	12	0.47	0.3	2.8	11	0.293	77
Cotton	PU	All	36	-0.04	0.0	34	0.26	0.1	2.4	33	0.234	78
		PERME	12	+0.42	2.0	10	0.49	2.0	0.8	9	0.234	82
		Cloncurry	7	+0.44	1.2	5	0.58	1.2	0.8	4	0.203	111
		Innisfail	13	-0.66	8.4	11	0.73	9.3	2.3	10	0.248	28
Cotton	CSPE	All	45	-0.32	4.8	43	0.34	4.8	0.8	42	0.492	131
		PERME	15	-0.46	3.2	13	0.52	3.4	1.1	12	0.483	149
		Cloncurry	12	+0.10	0.1	10	0.10	0.1	0.0	9	0.526	122
		Innisfail	14	+0.10	0.2	12	0.18	0.1	0.3	11	0.506	129

NOTES a One degree of freedom
b Sign not defined

Table 4

TEST FOR EQUALITY OF ABRASION ERROR VARIANCES

Set	No. of highest ranges omitted	No. of degrees of freedom	s^2
(a)	0	15	16.2
(b)	0	46	70.8
(b)	2	44	61.2
(c)	0	95	132.2
(c)	2	93	118.8
(d)	0	45	48.6
(e)	0	61	103.4
(e)	7	54	75.9
(f)	0	47	76.5
(f)	3	44	59.4
(g)	0	47	49.6
(h)	0	47	58.0
(i)	0	71	85.5

Table 5

ANALYSIS OF ERRORS

Property	Set								
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Error variance	8.303	21.399	24.460	30.654	47.391	27.262	63.122	21.175	36.523
Standard deviation	2.882	4.626	4.946	5.537	6.884	5.221	7.945	4.602	6.043
Coefficient of variation, %	8.8	9.7	9.3	9.3	12.2	10.7	18.1	9.9	8.4
Set mean, g/m^2 per 1000 cycles	32.91	47.48	53.43	59.47	56.59	48.92	43.86	46.40	72.32
Number degrees of freedom in error	16	48	96	48	64	48	48	48	72

Table 6

TABLE OF VARIANCE RATIOS

Effect	No. of degrees of freedom	No. of levels	No. of results per level	Set								
				(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
F	1	2	16	372.3								
F	1	2	48		327.2		157.4		375.1	124.7	273.8	
F	1	2	96			640.7						
F	1	2	64					287.0				
R	3	4	8	696.5								
R	3	4	24		726.3				588.9	238.1	340.4	
R	3	4	48			851.1						
R	3	4	32					560.6				
R	2	3	48									1389.6
T	1	2	16	7.4								
T	3	4	48			88.5						
T	3	4	24				84.7					
T	3	4	32					22.0				
T	5	6	16						105.8	20.5	201.3	
T	3	4	36									16.8
L	1	2	48		2.2		1.5					
L	1	2	64					0.3				
L	1	2	72									0.3
S	2	3	32		41.1		166.2					
S	2	3	64			27.3						
S	2	3	48									156.2

Table 6 (continued)

Effect	No. of degrees of freedom	No. of levels	No. of results per level	Set								
				(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
FR	3	8	4	247.9								
FR	3	8	12		348.6				308.6	109.9	239.1	
FR	3	8	24			552.4						
FR	3	8	16					280.5				
FT	1	4	8	4.5								
FT	3	8	24			3.0						
FT	3	8	12				1.3					
FT	3	8	16					7.4				
FT	5	12	8						1.5	1.6	13.7	
FL	1	4	24		1.3		1.5					
FL	1	4	32					0.2				
FS	2	6	16		19.0		34.8					
FS	2	6	32			10.6						
RT	3	8	4	9.7								
RT	9	16	12			30.6						
RT	9	16	8					20.9				
RT	15	24	4						38.3	5.6	48.5	
RT	6	12	12									26.4
RL	3	8	12		0.5							
RL	3	8	16					0.7				
RL	2	6	24									0.1

Table 6 (continued)

Effect	No. of degrees of freedom	No. of levels	No. of results per level	Set (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
RS	6	12	8		33.7							
RS	6	12	16			91.9						
RS	4	9	16									56.5
TL	3	8	12				2.7					
TL	3	8	16					1.0				
TL	3	8	18									2.2
TS	6	12	16			64.0						
TS	6	12	8				25.6					
TS	6	12	12									17.5
LS	2	6	16		0.5		4.1					
LS	2	6	24									2.9
FRT	3	16	2	1.7								
FRT	9	32	6			18.4						
FRT	9	32	4					8.0				
FRT	15	48	2						6.4	2.3	14.0	
FRL	3	16	6		2.6							
FRL	3	16	8					2.2				
FRS	6	24	4		68.1							
FRS	6	24	8			24.0						
FTL	3	16	6				1.2					
FTL	3	16	8					2.5				

Table 6 (concluded)

Effect	No. of degrees of freedom	No. of levels	No. of results per level	Set (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
FTS	6	24	8			14.4						
FTS	6	24	4				11.5					
FLS	2	12	8		3.6		4.2					
RTL	9	32	4					1.3				
RTL	6	24	6									2.0
RTS	18	48	4			29.5						
RTS	12	36	4									17.7
TLS	6	24	4				1.8					
TLS	6	24	6									1.7
LSR	6	24	4		2.5							
LSR	4	18	8									2.1
FRTL	9	64	2					1.7				
FRTS	18	96	2			15.5						
FTLS	6	48	2				1.2					
FLSR	6	48	2		1.3							
RTLS	12	72	2									2.2

Table 7

MEAN ABRASION MASS LOSSES, g/m^2 PER 1000 CYCLES

Factor	Level	Set (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
F	Nylon	42.74	56.02	62.48	66.56	66.90	59.24	52.92	54.17	
	Cotton	23.08	38.93	44.38	52.38	46.28	38.59	34.81	38.62	
R	Natural	23.09	51.41	58.79		77.32	59.20	39.62	41.84	66.56
	Neoprene	19.40	46.25	52.30		53.31	43.03	41.65	39.29	43.07
	PU	16.14	15.12	26.18		17.06	16.25	16.80	32.71	
	CSPE	73.01	77.12	76.45		78.67	77.18	77.38	71.74	107.33
T	Original	31.51					31.51	31.51	31.51	
	Final	34.29					34.29	34.29	34.29	
	3 months			48.17	51.41	52.54	53.47	49.65	41.36	70.23
	6 months			58.54	62.35	52.76	51.48	49.52	74.62	74.83
	12 months			59.92	72.97	64.76	66.23	53.56	56.49	76.60
	6S months			47.08	51.16	56.30	56.50	44.63	40.09	67.62
S	PERME		52.54	56.93	77.32					83.15
	Cloncurry		49.63	50.37	50.77					72.46
	Innisfail		40.25	52.99	50.33					61.35
FR	Nylon/Natural	31.25	56.54	66.58		90.43	72.61	46.09	45.67	
	Nylon/Neoprene	15.24	42.65	43.25		43.03	34.63	35.92	31.18	
	Nylon/PU	18.78	13.37	32.14		18.14	17.51	18.87	41.20	
	Nylon/CSPE	105.68	111.50	107.96		115.99	112.19	110.79	98.62	
	Cotton/Natural	14.93	46.28	51.01		64.21	45.79	33.14	38.01	
	Cotton/Neoprene	23.55	49.84	61.35		63.59	51.43	47.38	47.40	
	Cotton/PU	13.50	16.87	20.22		15.98	14.99	14.73	24.22	
	Cotton/CSPE	40.34	42.74	44.93		41.35	42.17	43.98	44.87	
FS	Nylon/PERME		61.76	67.49	90.43					
	Nylon/Cloncurry		61.35	60.06	57.33					
	Nylon/Innisfail		44.94	59.90	51.94					
	Cotton/PERME		43.33	46.36	64.21					
	Cotton/Cloncurry		37.91	40.68	44.22					
	Cotton/Innisfail		35.57	46.09	48.72					

Table 7 (continued)

Factor	Level	Set (a) Natural	Set (a) Neoprene	Set (a) PU	Set (a) CSPE	Set (c) Natural	Set (c) Neoprene	Set (c) PU	Set (c) CSPE	Set (e) Natural	Set (e) Neoprene	Set (e) PU	Set (e) CSPE
RT	Original	23.12	18.14	17.64	67.16								
	Final	23.06	20.61	14.64	78.87								
	3					53.09	46.81	15.27	77.50	68.16	46.28	21.27	74.44
	6					59.71	53.05	42.79	78.60	67.80	51.31	16.32	75.61
	12					72.76	62.31	33.00	71.61	105.13	66.58	13.34	73.99
	6S					49.61	47.01	13.64	78.06	68.18	49.06	17.32	90.64

Factor	Level	Set (f) Natural	Set (f) Neoprene	Set (f) PU	Set (f) CSPE	Set (g) Natural	Set (g) Neoprene	Set (g) PU	Set (g) CSPE
RT	Original	23.12	18.14	17.64	67.16	23.12	18.14	17.64	67.16
	Final	23.06	20.61	14.64	78.87	23.06	20.61	14.64	78.87
	3	66.94	47.52	21.42	78.02	42.94	50.32	14.65	90.70
	6	67.74	53.73	14.90	69.55	50.26	56.60	14.64	76.58
	12	108.22	66.16	14.26	78.28	54.50	58.02	27.49	74.21
	6S	66.14	52.03	14.61	93.22	43.81	46.20	11.73	76.80

Factor	Level	Set (h) Natural	Set (h) Neoprene	Set (h) PU	Set (h) CSPE	Set (i) Natural	Set (i) Neoprene	Set (i) CSPE
RT	Original	23.12	18.14	17.64	67.16			
	Final	23.06	20.61	14.64	78.87			
	3	49.38	42.60	9.76	63.71	56.54	42.65	111.50
	6	61.14	48.82	98.84	89.69	70.19	40.52	113.78
	12	55.56	62.76	40.80	66.85	80.65	51.57	97.59
	6S	38.77	42.82	14.58	64.18	58.87	37.52	106.46

Table 7 (continued)

Factor	Level	Set										
		(b)				(c)				(i)		
		Natural	Neoprene	PU	CSPE	Natural	Neoprene	PU	CSPE	Natural	Neoprene	CSPE
RS	PERME	68.16	46.28	21.27	74.44	77.26	54.86	16.30	79.28	90.42	43.03	115.99
	Cloncurry	42.30	50.72	14.16	91.35	47.88	52.79	21.24	79.57	57.33	46.46	113.61
	Innisfail	43.77	41.74	9.93	65.57	51.24	49.25	40.99	70.48	51.94	39.71	92.40

Factor	Level	Set											
		(c)				(d)				(i)			
		3	6	12	6S	3	6	12	6S	3	6	12	6S
TS	PERME	53.49	51.48	66.23	56.50	68.16	67.80	105.13	68.18	75.49	78.92	90.98	86.31
	Cloncurry	49.65	49.52	57.67	44.63	42.30	56.26	58.88	45.65	77.94	72.37	74.60	64.95
	Innisfail	41.36	74.62	55.87	40.11	43.77	62.99	54.91	39.66	57.26	72.31	64.95	51.60

Table 7 (continued)

Factor	Level		Set (c) Natural	Set (c) Neoprene	Set (c) PU	Set (c) CSPE	Set (e) Natural	Set (e) Neoprene	Set (e) PU	Set (e) CSPE
FRT	Nylon	Original								
		Final								
		3	56.71	45.30	13.95	112.99	76.98	48.06	20.56	101.43
		6	68.39	40.68	54.54	109.79	80.61	36.49	19.52	122.35
		12	82.60	48.14	47.63	100.57	118.42	48.64	10.96	105.90
		6S	58.62	38.86	12.43	108.48	85.71	38.93	21.53	134.28
	Cotton	Original								
		Final								
		3	49.47	48.32	16.60	42.00	59.35	44.51	21.99	47.46
		6	51.04	65.42	31.05	47.42	54.98	66.12	13.12	28.87
		12	62.92	76.48	18.37	42.66	91.85	84.53	15.71	42.08
		6S	40.60	55.17	14.85	47.66	50.66	59.18	13.11	46.99

Factor	Level		Set (f) Natural	Set (f) Neoprene	Set (f) PU	Set (f) CSPE	Set (h) Natural	Set (h) Neoprene	Set (h) PU	Set (h) CSPE
FRT	Nylon	Original	32.44	16.06	19.48	101.74	32.44	16.06	19.48	101.74
		Final	30.66	14.41	18.08	109.62	30.06	14.41	18.08	109.62
		3	74.97	52.65	21.04	110.50	50.16	37.94	8.16	90.06
		6	85.12	35.22	17.95	111.30	61.16	38.78	135.45	118.92
		12	127.28	48.63	12.76	108.04	60.55	47.08	54.06	86.10
		6S	85.81	40.81	15.73	131.96	39.66	32.82	11.96	85.24
	Cotton	Original	13.79	20.21	15.80	32.58	13.79	20.21	15.80	32.58
		Final	16.07	26.80	11.20	48.11	16.07	26.80	11.20	48.11
		3	58.90	42.39	21.80	45.54	48.60	47.26	11.34	37.36
		6	50.37	72.24	11.86	28.70	61.12	58.86	62.22	60.47
		12	89.14	83.68	15.76	44.53	50.58	78.43	27.54	47.60
		6S	46.48	63.25	13.49	54.48	37.87	52.82	17.20	43.12

Table 7 (continued)

Factor	Level		Set							
			(b)				(c)			
			Natural	Neoprene	PU	CSPE	Natural	Neoprene	PU	CSPE
FRS	Nylon	PERME	76.98	48.02	20.36	101.43	93.30	44.33	16.78	115.45
		Cloncurry	46.50	45.34	11.60	141.99	53.51	46.26	27.14	113.34
		Innisfail	46.14	34.56	7.95	91.08	52.94	39.15	52.41	95.08
	Cotton	PERME	59.35	44.51	21.99	47.46	61.22	65.39	15.73	43.12
		Cloncurry	38.10	56.16	16.72	40.72	42.25	59.31	15.34	45.79
		Innisfail	41.40	48.91	11.91	40.06	49.54	59.34	29.58	45.89

Factor	Level		Set							
			(c)				(d)			
			3	6	12	6S	3	6	12	6S
FTS	Nylon	PERME	64.79	62.40	74.18	68.58	76.98	80.61	118.42	85.71
		Cloncurry	60.35	54.08	73.08	52.74	46.50	68.64	64.24	49.93
		Innisfail	46.58	88.58	61.95	42.48	46.14	61.32	59.31	40.98
	Cotton	PERME	42.19	40.56	58.28	44.42	59.35	54.99	91.85	50.66
		Cloncurry	38.96	44.96	42.25	36.53	38.10	43.88	53.53	41.38
		Innisfail	36.14	60.67	49.78	37.75	41.40	64.66	50.51	38.33

Table 7 (continued)

Factor	Level		Set (c) 3	(c) 6	(c) 12	(c) 6S	(i) 3	(i) 6	(i) 12	(i) 6S
RTS	PERME	Natural	66.94	67.74	108.22	66.14	76.98	80.61	118.42	85.71
		Neoprene	47.52	53.73	66.16	52.03	48.06	36.49	48.64	38.93
		PU	21.42	14.90	14.26	14.61				
		CSPE	78.08	69.54	76.28	93.22	101.43	122.35	105.90	134.28
	Cloncurry	Natural	42.94	50.26	54.50	43.81	46.50	68.64	64.24	49.93
		Neoprene	50.32	56.60	58.02	46.20	45.34	46.38	53.90	40.23
		PU	14.65	14.64	43.94	11.73				
		CSPE	90.70	76.58	74.21	76.80	141.99	102.08	105.67	104.68
	Innisfail	Natural	49.38	61.14	55.56	38.88	46.14	61.32	59.31	40.98
		Neoprene	42.60	48.82	62.76	42.82	34.56	38.70	52.16	33.41
		PU	9.76	98.84	40.80	14.58				
		CSPE	63.71	89.69	64.35	64.18	91.08	116.90	81.21	80.41

Table 7 (concluded)

Factor	Level			Set (c) 3	6	12	6S
FRTS	Nylon	PERME	Natural	74.97	85.12	127.28	85.81
			Neoprene	52.65	35.22	48.63	40.81
			PU	21.04	17.95	12.76	15.73
			CSPE	110.50	111.30	108.04	131.96
		Cloncurry	Natural	44.99	58.89	59.98	50.18
			Neoprene	45.33	48.04	48.71	42.96
			PU	12.66	10.22	76.07	9.60
			CSPE	138.42	99.15	107.58	108.22
		Innisfail	Natural	50.16	61.16	60.55	39.89
			Neoprene	37.94	38.78	47.08	32.82
			PU	8.16	135.45	54.06	11.96
			CSPE	90.06	118.92	86.10	85.24
	Cotton	PERME	Natural	58.90	50.37	89.14	46.48
			Neoprene	42.39	72.24	83.68	63.25
			PU	21.80	11.86	15.76	13.49
			CSPE	45.68	27.80	44.53	54.48
		Cloncurry	Natural	40.90	41.63	49.04	37.44
			Neoprene	55.32	65.16	67.34	49.44
			PU	16.65	19.06	11.80	13.86
			CSPE	42.96	54.00	40.84	45.38
		Innisfail	Natural	48.60	61.12	50.58	37.87
			Neoprene	47.26	58.86	78.43	52.81
			PU	11.34	62.22	27.54	17.20
			CSPE	37.36	60.47	42.60	43.12

Table 8

DIFFERENCES BETWEEN ABRASION MEANS, g/m^2 PER 1000 CYCLES, AT 99.9% PROBABILITY

Effect	Set								
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
F	4.10	3.30	2.43	3.96	4.20	3.73	5.68	3.29	
R	5.79	4.67	3.43		5.94	5.28	8.03	4.65	4.24
T	4.10		3.43	5.59	5.94	6.46	9.83	5.69	4.90
L		3.30		3.96	4.20				3.46
S		4.05	2.97	4.84					4.24
FR	11.58	9.35	6.86		11.88	10.55	16.05	9.30	
FT	8.19		6.86	11.19	11.88	12.92	19.66	11.39	
FL		6.61		7.91	8.40				
FS		8.10	5.94	9.69					
RT	11.58		9.71		16.79	18.27	27.81	16.11	12.00
RL		9.35			11.88				8.49
RS		11.45	8.41						10.39
TL				11.19	11.88				9.80
TS			8.41	13.70					12.00
LS		8.10		9.69					8.49
FRT	23.17		19.42		33.59	36.55	55.61	32.21	
FRL		18.70			23.75				
FRS		22.90	16.82						
FTL				22.38	23.75				
FTS			16.82	27.40					
FLS		16.19		19.38					
RTL					33.59				24.01
RTS			23.78						29.40
TLS				27.40					24.01
LSR		22.90							20.79
FRTL					67.18				
FRTS			47.56						
FTLS				54.81					
FLSR		45.79							
RTLS									58.80

REFERENCES

No.	Author	Title, etc
1	J.E. Swallow M. Webb	The flexibility of weathered rubber-coated fabrics. RAE Technical Report 77016 (1977)
2	J.E. Swallow M. Webb	The breaking strength and extension of weathered rubber-coated fabrics. RAE Technical Report 77031 (1977)
3	J.E. Swallow A.R. Wakefield	The tearing of weathered rubber-coated fabrics. RAE Technical Report 78005, MQAD Report R264 (1978)
4	British Standards Institution	Methods of test for coated fabrics. Method 27 : determination of abrasion resistance. BS 3424 (1973)
5	British Standards Institutation	Resistance of fabrics to penetration by water (hydrostatic head test). BS 2823 (1968)

REPORT DOCUMENTATION PAGE

Overall security classification of this page

UNLIMITED

As far as possible this page should contain only unclassified information. If it is necessary to enter classified information, the box above must be marked to indicate the classification, e.g. Restricted, Confidential or Secret.

1. DRIC Reference (to be added by DRIC)	2. Originator's Reference	3. Agency Reference	4. Report Security Classification/Marking
	RAE TR 80124	N/A	UNLIMITED

5. DRIC Code for Originator	6. Originator (Corporate Author) Name and Location
7673000W	Royal Aircraft Establishment, Farnborough, Hants, UK
5a. Sponsoring Agency's Code	**6a. Sponsoring Agency (Contract Authority) Name and Location**
N/A	N/A

7. Title

Abrasion and hydrostatic head of weathered rubber-coated fabrics

7a. (For Translations) Title in Foreign Language

7b. (For Conference Papers) Title, Place and Date of Conference

8. Author 1. Surname, Initials	9a. Author 2	9b. Authors 3, 4	10. Date	Pages	Refs.
Swallow, J.E.	Wakefield, A.R.		October 1980	31	5
11. Contract Number	**12. Period**	**13. Project**	**14. Other Reference Nos.**		
N/A	N/A		Mat 411		

15. Distribution statement
(a) Controlled by – DRIC
(b) Special limitations (if any) –

16. Descriptors (Keywords) (Descriptors marked * are selected from TEST)

Abrasion. Hydrostatic head. Coated fabrics. Weathering.

17. Abstract

The abrasion mass loss and hydrostatic head of a nylon and of a cotton fabric, each coated with natural rubber, neoprene, polyurethane (PU) or chlorosulphonated polyethylene (CSPE) and exposed to various weathering conditions, were determined.

Correlations between hydrostatic head and abrasion mass loss were generally low.

During abrasion, coated nylon fabrics lost more mass than coated cotton fabrics. CSPE was most susceptible to abrasion, particularly on nylon, though with little dependence on conditions of exposure. Neoprene was worse on cotton. PU had the lowest mass loss and least susceptibility to exposure conditions, except at Innisfail. Natural rubber lost more mass on abrasion than neoprene or PU, especially at PERME. Load during exposure had a negligible effect.

END

DATE
FILMED
5 81

DTIC